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The economic impact of SARS: How does the reality match the predictions?

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Abstract

Objectives: To perform a retrospective analysis of the macro-economic impact of the 2003 Severe Acute Respiratory Syndrome (SARS) outbreak.

Methods: As several years have now passed, it is possible to interrogate national statistics that have become available since the outbreak to provide a more accurate estimate of the actual macro-economic impact of SARS. National statistics were examined for anomalies that corresponded to the timing of the SARS outbreak and, where possible, the size of any gain or loss found estimated.

Results: Estimates and models produced at the time of the outbreak suggested that SARS could have a catastrophic effect on the global economy. Our analysis suggests that the scale of the SARS impact on affected economies was far smaller than suggested by contemporary media reports and model estimates.

Conclusions: This exercise holds important lessons for estimating the economic impact of future outbreaks – such as pandemic influenza – and measures to control or prevent them. We suggest that further work is needed to develop a more comprehensive macro-economic model able to more accurately estimate the relative cost and effect of a global response to outbreaks of international concern. The implications of our findings are discussed in the light of a prospective influenza pandemic.

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1. Introduction

Severe Acute Respiratory Syndrome (SARS) is an infectious disease that can be spread between humans [1]. It emerged in late 2002 and was transmitted in a similar way to the cold virus [2]. Having started in the Guandong province of China, the dis-

ease was transmitted with great rapidity to Australia, Brazil, Canada, China, Hong Kong, South Africa, Spain and the USA. This led to serious public health concerns. The SARS outbreak peaked during the second quarter of 2003 and was declared over by July 2003. Although approximately 10,000 individuals were infected, of which 10% died, the overall impact on health was far less devastating than initially feared.

The SARS outbreak was also perhaps the first instance of a concurrent global concern for the

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economic impact that might result (previous concerns, such as those surrounding Foot and Mouth disease, being national or regional in nature). The possible economic impact of SARS was thus also the focus of various estimations and some conjecture. During the outbreak, there was a noticeable downturn in travel and tourism income for many infected countries. It was also anticipated that fear of disease would impact those industries which gather people in public places such as restaurants, cinemas and retail establishments [3].

Although confounded by the simultaneous ‘war on terror’, and specifically the Iraq conflict, several models of the possible economic impact of SARS were constructed [4–7]. The results of these modelling exercises suggested estimates of the economic impact between US\$ 30–100 billion (around US\$ 3–10 million per case). These estimates were used by the media to support views that, for example, “Hong Kong itself has been hammered”¹ or, in *Time* magazine, that “SARS was an economic disaster: could bird flu be as bad?”². This latter case illustrates popular and professional concern that SARS was a ‘dry run’ for an even greater global calamity of pandemic influenza [8,9].

Given this concern for future outbreaks, it is worth considering whether the actual economic impact of SARS was as devastating as predicted, which countries and sectors were most affected, and why. As it is now several years since the SARS outbreak, it is possible to address such issues more definitively through published national statistics. Moreover, it is possible to evaluate the actual effect of SARS and compare this with the predictions made at the time of the outbreak before data was available.

Following this introduction, the paper outlines the methods used to estimate the economic effect from national statistics databases, presents the results of this analysis and then draws conclusions with regard to the overall economic effect of SARS, some of the possible explanations for that effect, and some suggested implications of these findings.

2. Methods

The basic units of assessment are country and economic sector. Each country/sector is then assessed by a specific economic indicator. These countries, sectors and indicators are each defined below, together with data sources and method of estimation.

2.1. Countries assessed

Countries were chosen on the basis of having had some presence of SARS. It is accepted that countries who did not actually have any cases may also have been affected, such as by increased tourism due to avoidance of infected countries, or ‘effects of association’ for those in relatively close proximity to those with SARS cases. With the caveat that these countries may also have had some impact attributable to SARS, the analysis reported here is based on countries which had at least five cases of SARS as recorded by the WHO, reported in Table.

2.2. Estimation

The method of estimation used to calculate the size of losses or gains in the data varied according to the availability of data for comparison. The calculation method used for each estimate is described in the relevant results section. The time period most likely to exhibit effects from SARS is the second quarter of 2003 with a smaller effect in the third quarter (see Table 1). For some Asian countries the possibility of economic effect in the first quarter has also been permitted since those countries also had SARS cases in the first quarter of 2003. Seasonality in monthly and quarterly data was taken into account and, where possible, each data item was compared with the corresponding data item of the previous and/or succeeding year. However, in some cases the scarcity of data did not permit such comparison, and a comparison of points within the same year was therefore necessary.

Where losses or gains occurred at the time of the SARS outbreak, either second quarter 2003 or in 2003 annual data, the surrounding data were used to calculate an estimated gain or loss value. For quarterly/monthly figures, the equivalent quarters/months in 2002 and 2004 (where available) were used to calculate an average or expected 2003 value in the

¹ http://money.cnn.com/magazines/fortune/fortune_archive/2003/04/28/341725/index.htm.

² *Time* Asia Monday, February 2, 2004 http://www.time.com/time/asia/covers/501040209/birdflu_impact.html.

Table 1
Cases of SARS from WHO

Areas	Cumulative number of cases			No. of deaths	Case fatality ratio (%)	No. of HCW affected (%)	Date onset first probable case	Date onset last probable case
	Female	Male	Total					
Australia	4	2	6	0	0	0 (0)	26-February-03	1-April-03
Canada	151	100	251	43	17	109 (43)	23-February-03	12-June-03
China	2674	2607	5327	349	7	1002 (19)	16-November-02	3-June-03
China, Hong Kong Special Administrative Region	977	778	1755	299	17	386 (22)	15-February-03	31-May-03
China, Macao Special Administrative Region	0	1	1	0	0	0 (0)	5-May-03	5-May-03
China, Taiwan	218	128	346	37	11	68 (20)	25-February-03	15-June-03
France	1	6	7	1	14	2 (29)	21-March-03	3-May-03
Germany	4	5	9	0	0	1 (11)	9-March-03	6-May-03
India	0	3	3	0	0	0 (0)	25-April-03	6-May-03
Indonesia	0	2	2	0	0	0 (0)	6-April-03	17-April-03
Italy	1	3	4	0	0	0 (0)	12-March-03	20-April-03
Kuwait	1	0	1	0	0	0 (0)	9-April-03	9-April-03
Malaysia	1	4	5	2	40	0 (0)	14-March-03	22-April-03
Mongolia	8	1	9	0	0	0 (0)	31-March-03	6-May-03
New Zealand	1	0	1	0	0	0 (0)	20-April-03	20-April-03
Philippines	8	6	14	2	14	4 (29)	25-February-03	5-May-03
Republic of Ireland	0	1	1	0	0	0 (0)	27-February-03	27-February-03
Republic of Korea	0	3	3	0	0	0 (0)	25-April-03	10-May-03
Romania	0	1	1	0	0	0 (0)	19-March-03	19-March-03
Russian Federation	0	1	1	0	0	0 (0)	5-May-03	5-May-03
Singapore	161	77	238	33	14	97 (41)	25-February-03	5-May-03
South Africa	0	1	1	1	100	0 (0)	3-April-03	3-April-03
Spain	0	1	1	0	0	0 (0)	26-March-03	26-March-03
Sweden	3	2	5	0	0	0 (0)	28-March-03	23-April-03
Switzerland	0	1	1	0	0	0 (0)	9-March-03	9-March-03
Thailand	5	4	9	2	22	1 (11)	11-March-03	27-May-03
United Kingdom	2	2	4	0	0	0 (0)	1-March-03	1-April-03
United States	13	14	27	0	0	0 (0)	24-February-03	13-July-03
Vietnam	39	24	63	5	8	36 (57)	23-February-03	14-April-03
Total			8096	774	9.6	1706		

absence of SARS. Where quarterly/monthly data was not available for the surrounding years, the surrounding quarters/months were used (i.e. quarters one and three used to estimate the second quarter). For annual figures, data from the surrounding years was used to estimate 2003 data in the absence of SARS, using the previous and successive year's average where possible, but also taking into account any trend in

neighbouring data. Occasionally graphical representations of the data were available, but the numerical data itself was missing. In such cases losses have been estimated by estimating the numerical values from the graphs and then proceeding as for numerical data.

Having formed these non-SARS estimates, the actual data for the period of loss/gain was subtracted

from the estimated (non-SARS) value for the period of loss/gain to form loss/gain estimates of the economic impact of SARS.

2.3. Economic indicators and sectors

For consistency the same economic indicators and sectors were estimated for each country. These indicators and sectors are those that are most likely to be impacted by both the changes in the public's perception of the risk of SARS associated with that country, the impact of infection with SARS and the impact of interventional policies implemented to contain SARS. For instance the avoidance of public places by natives together with the avoidance of a certain country by tourists will mainly impact the retail, tourism and entertainment related sectors. It is worth noting that as this paper presents observational data, we cannot divorce the impact of SARS and the impact of policies to contain SARS. The importance of this in the interpretation of the results is referred to in the discussion.

The chosen indicators were:

- GDP (the country's Gross Domestic Product).
- Growth (GDP growth from the previous year).
- Exports and Trade (the country's total export revenue or total trade with other countries).
- Budget (government budget, expenditure and revenue).

The chosen sectors were:

- Health (total health expenditure for the country).
- Tourism (total revenue from the tourism sector).
- Hotels (total revenue from hotels and or boarding houses³).
- Airlines (total revenue for airline sector).
- Retail (total revenue from retail sales).
- Restaurants (total revenue from food and restaurants).
- Entertainment (total revenue from leisure and entertainment activities).
- IT (total revenue in the computer or information technology sector).

³ For all countries and sectors studied, the Figs. reported are for either hotels or hotels and boarding houses (indivisible) but not just boarding houses.

GDP and growth are of obvious importance in capturing the overall economic impact on a country. However, exports, trade and investment have been considered as likely to exhibit economic effects [4–6]. In addition to considering tourism as a whole, we decided to separate the tourism impact into hotels, airlines and restaurants as the SARS impact may affect some of these sectors more than others. The entertainment industry was included as it is likely to exhibit an effect if people avoid public places in an attempt to escape SARS and the IT sector was included as it will reflect an increase in the number of people working from home via the internet to avoid exposure to SARS whilst at work or travelling to work. The health sector was included as it will reflect an increase in medical expenditure due to SARS.

2.4. Data sources

National statistics databases for countries of interest were interrogated in order to locate data on the above sectors and indicators. Where search facilities were offered, the keyword representing the sector was used to locate the data. The statistical data sections were also searched by hand for the appropriate data. A list of the national statistics databases used is available from the first author on request.

3. Results

3.1. Overview

Countries, sectors and indicators for which national statistics data was found are indicated in Table 2. Each country had at least five cases of SARS, but Mexico was omitted since the national statistics web site was in Spanish only.

Overall, the largest economic impact of SARS was related to overall GDP and investment, and sectors representing hotels and restaurants and tourism. The vast majority of losses were experienced in China and Hong Kong, with more minor effects in Canada and Singapore. However, these losses rarely affected more than one quarter's data and often only adversely affected the economy for a single month. It should also be noted that in many cases the losses were

Table 2

Countries, sectors and indicators for which national statistics data was found (✓ means data was found for this indicator/sector)

Country	Indicators				Sectors							
	GDP	Growth	Exports and trade	Budget	Health	Tourism	Hotels	Airlines	Retail	Restaurants	Entertain	IT
China	✓	✓	✓	✓		✓			✓			
Hong Kong	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Canada	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Singapore	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓✓		✓
Malaysia	✓	✓	✓	✓		✓						
Vietnam	✓	✓	✓			✓	✓		✓	✓		
Thailand	✓		✓	✓	✓	✓	✓			✓		
United States	✓	✓	✓		✓	✓		✓		✓	✓	
Taiwan	✓	✓	✓	✓	✓				✓			
Australia	✓	✓	✓		✓	✓	✓		✓	✓		
Germany	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Japan	✓		✓	✓	✓	✓			✓			✓
Mongolia			✓					✓				
Philippines	✓		✓	✓	✓							
France	✓		✓	✓				✓				
Sweden	✓		✓	✓			✓	✓	✓	✓		

succeeded by (often equivalent) gains in the following month, quarter or year, such that over a year the effect was marginal at best. The impact from SARS, where it occurred, was therefore usually very short-term.

3.2. Indicators

Although many items of data have been obtained (see Table 2) many of the sectors and indicators examined showed little or no SARS effect. Often an effect of magnitude less than one percent is not distinguishable from the rest of the series and unless an anomaly in the data can be clearly viewed in the plot of the series, we have classified the impact as “no evidence of a loss”. Here, we present some examples of cases where a notable effect was found and then summarise our findings.

3.3. Examples

3.3.1. GDP

3.3.1.1. Hong Kong GDP. An example of GDP loss is provided in Fig. 1 for Hong Kong. The values for the first and second quarters of 2003 are clearly lower than the surrounding values. Subtracting the first quarter value 2003 from the average of the first quarter val-

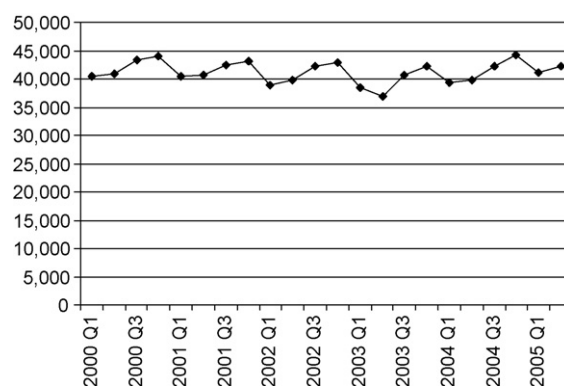


Fig. 1. Hong Kong GDP (HK\$ million).

ues for 2002 and 2001 estimates the loss for the first quarter. Calculating the loss for the second quarter in the same way and summing these losses yields a loss estimate of HK\$ 29081.5 million or US\$ 3.7 billion. However, it should be noted that before the end of the year, GDP had returned to pre-SARS levels and 2004 shows slight growth over previous years.

3.3.1.2. China GDP. Table 3 shows the loss to China GDP growth in the second quarter of 2003. Averaging the first, third and fourth quarter, the second quarter loss is estimated as 3.1% for the quarter.

Table 3
China GDP growth 2003

Quarter	GDP growth (%)
First quarter	9.9
Second quarter	6.7
Third quarter	9.6
Fourth quarter	9.9

Source: NBS

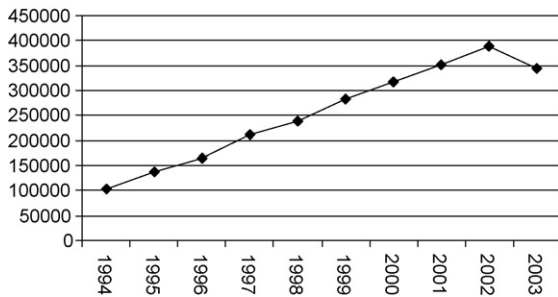


Fig. 2. China domestic tourism earnings (million yuan).

3.3.2. Tourism

3.3.2.1. China domestic tourism. Fig. 2 shows China's domestic tourism earnings and a large loss for 2003 based on the linear rise in previous years. Taking the average increase from 1994 to 2002 and adding it to the 2002 figure an estimate for 2003 is formed. Subtracting the real 2003 value from this estimate estimates the loss as 79291.63 million yuan or US\$ 3.5 billion.

3.3.2.2. Malaysian tourism. Fig. 3 shows a clear loss in 2003 for Malaysian tourism. Averaging 2002 and

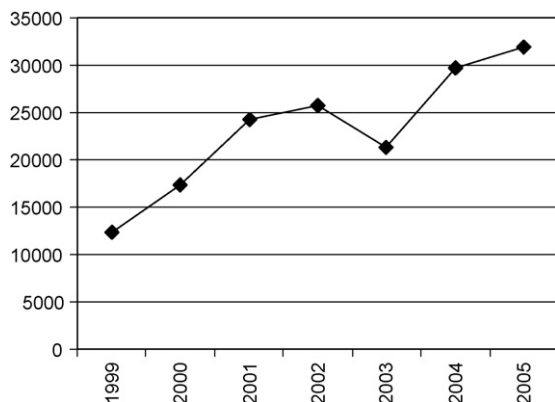


Fig. 3. Malaysia tourism (RM millions).

2004 the loss estimate is RM 6425.15 million = US\$ 1.7 billion.

3.3.3. Hotels and restaurants

3.3.3.1. Hong Kong restaurants. Fig. 4 shows the Hong Kong restaurant sector. This plot clearly indicates a sharp decline in restaurant receipts in the second quarter of 2003; also the first quarter figure is slightly lower than previous quarters possibly indicating the start of the decline which then declined further in March. The third quarter figure is also slightly low possibly indicating the end of the decline. It is reasonable to attribute the sharp decline, which is of the order of HK\$ 2000 million = US\$ 0.26 billion, to the SARS outbreak as the most obvious major potential effect on Hong Kong's economy for such a short period.

3.3.3.2. Canada accommodation and food. Fig. 5 shows a significant decline in the Canadian accommodation and food services sector from March 2003 to September 2003. This decline can be reasonably attributed to SARS since it corresponds to the appropriate timescale of the outbreak. It also suggests that this sector of Canada's economy did not recover immediately following the end of the disease scare. By averaging the figures for January, February, October, November and December 2003 and assuming that, aside from SARS, the data below would have continued along the same average value as the mean of those unaffected months, the estimated effect of SARS on the Canadian accommodation and food services sector is \$ 5272 million or US\$ 4.3 billion.

3.3.3.3. Australian accommodation and food. Fig. 6 shows Australian losses for accommodation and food due to SARS. The estimated loss in 2003–2004 is \$ 178 million = US\$ 0.12 billion assuming linear growth from previous years.

3.3.3.4. Singapore hotels. Fig. 7 shows a loss in the second quarter of 2003 to gazetted hotels in Singapore. If the second quarter data is assumed to be approximately similar to the first, third and fourth quarter, the estimated loss is approximately \$0.2 billion (Singapore) or US\$ 0.12 billion.

As shown in Table 2, GDP data was found for 15 countries and growth data was found for 11 countries. Of these, just three GDP series (Hong Kong, Canada

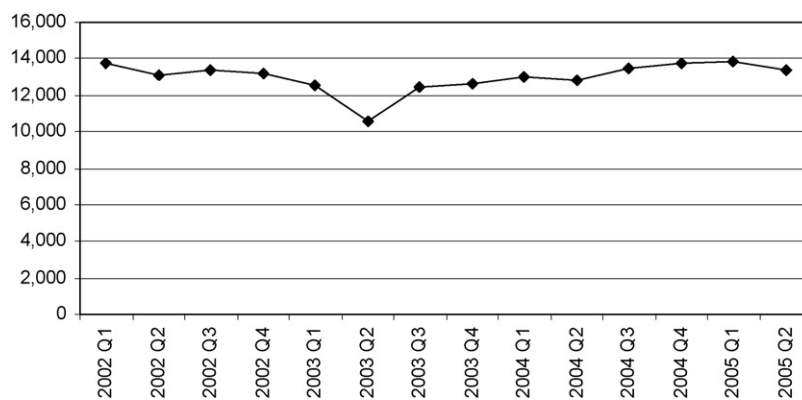


Fig. 4. Hong Kong restaurant sector (HK\$ million National Statistics).

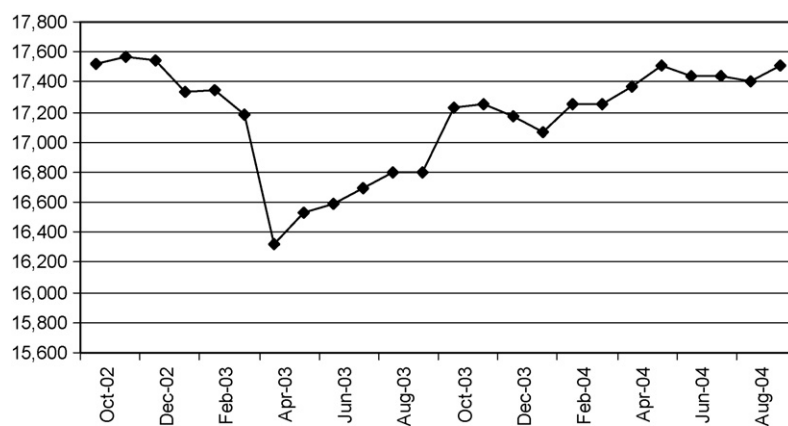


Fig. 5. Canada accommodation and food services sector (millions chained (1997) dollars).

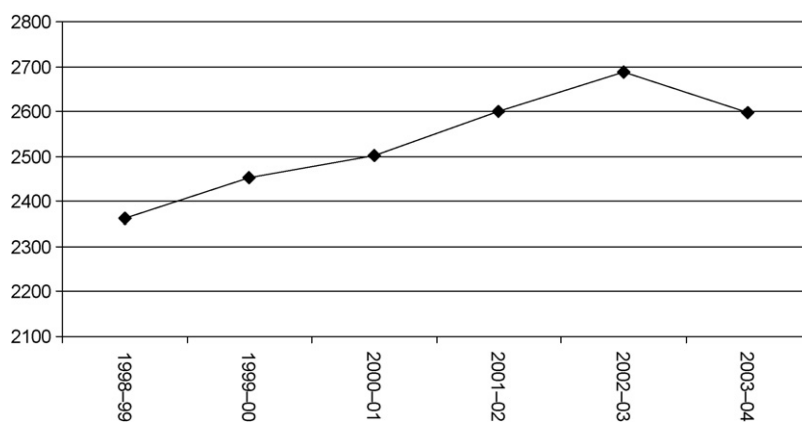


Fig. 6. Australia restaurant and food (Aus\$ millions).

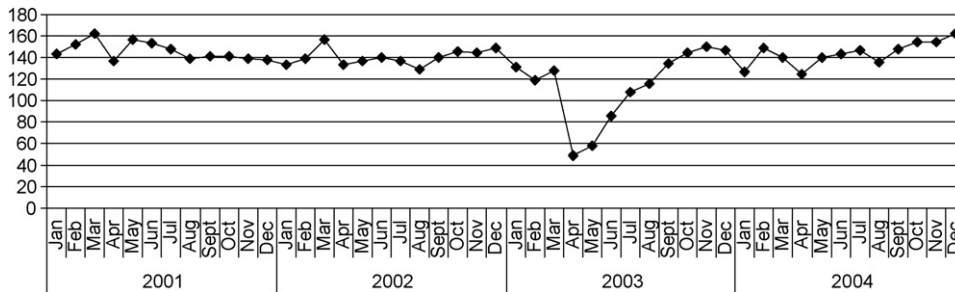


Fig. 7. Singapore gazetted hotels revenue (Singapore \$ million).

and Singapore) and five growth series (China, Hong Kong, Canada, Singapore and Taiwan) exhibited a noticeable effect that might be reasonably attributed to SARS. All other series displayed no noticeable decline at the time of the SARS outbreak.

In addition to GDP, there were two areas of the economy for which some significant adverse affects during the SARS outbreak were demonstrated. These are presented in Table 4. One can see from this that both exports and tourism demonstrate some signifi-

cant losses for certain Asian countries (note that for this table tourism groups together the tourism sector, restaurant sector and air travel sector).

In order to prevent confusion from Table 4 it is necessary to highlight certain tabulated items. First, the losses tabulated are not the only losses that might be attributed to SARS, although they do incorporate the largest impacts and all of the most affected sectors. As a result, the losses provided in the table are likely to be an under-estimate of the overall economic effect. It should

Table 4
Summary of main SARS impacts

	GDP (US\$ billion)	Growth	Exports and trade (US\$ billion)	Tourism, food and travel (US\$ billion)
China	←	↓3% in Q2	↓7.12 (FDI) but 0 (Exports)	↓5 (International) 3.5 (Domestic)
Hong Kong	↓3.7	↓4.75% in Q2	↓23.1 (Outward FDI)	↓0.86 (Tourism) 0.2 (Hotels) 0.26 (Restaurants)
Canada	↓3.2–6.4	↓1% for 2003	↓5.2 (Investment Outflow)	↓0.03 (Tourism) 6.25% (Airline) 4.33 (Accommodation and food)
Singapore	↓4.9	↓1% for 2003	←	↓0.2 (Hotels) 17.4% (Airline)
Malaysia	←	←	←	↓1.7
Vietnam	←	←	←	↓0.14 (Hotels and restaurants)
Thailand	←	?	←	←33.5 (Tourism)
United States	←	←	←	←
Taiwan	←	←	←	←
Australia	←	←	↓10.1% (2001–2002 decline also)	↓0.119 (Accommodation and food)
Germany	←	←	←	←
Japan	←	?	↓0 Exports but 3.5 (FDI out) and 2.9 (FDI in) but 2001–2002 decline also	←
Mongolia	?	?	←	←
Philippines	←	?	↓1.2 or 3%	←
France	←	?	←Losses in Q1–3 = Iraq war?	←
Sweden	↓Notable loss, probably not SARS	?	?	←

KEY: ↓ = SARS related loss, ← = no evidence of a loss, ? = missing data.

also be highlighted that whilst certain sectors may have experienced large economic losses (for example China tourism food and travel) these losses may be compensated in other areas of the economy and thus do not feature in the GDP loss estimate. Nevertheless the loss estimates do constitute an outright loss to their respective sectors since any compensatory gain elsewhere in the economy only serves to hide the loss to GDP.

4. Discussion

The analysis presented in this paper suggests that the economic impact of SARS was not as catastrophic as anticipated by contemporary estimates and models, or envisaged by the media at the time of the outbreak. SARS did have a notable affect on certain sectors of some East Asian and the Canadian economies. China and Hong Kong were clearly the worst affected areas and the sectors that exhibited greatest loss due to SARS were investment (inward and outward), retail sales, restaurants, hotels, tourism and air transport, of which the latter three in particular are influenced by tourism generally.

However, the reasons for the size of our estimates of the economic effect of SARS should also be examined. Most obviously, the Iraq conflict occurred almost simultaneously. It is also possible that, since the WHO took an active role in the SARS outbreak using its Global Outbreak Alert and Response Network (GOARN), the intervention by WHO and the input from this globalised network may have contributed to a reduction in the progression of the disease. However, for those countries, such as China and Hong Kong, where SARS became a real threat with a significant death toll, there were indeed some large short-term losses. However, these losses correspond only to the relatively short period of the disease outbreak, after which consumer confidence returned and many stocks that had diminished were replenished and some purchases which were forgone at the height of the outbreak were made after the perceived risk was reduced. This conjecture is supported by the rapid return to normality (bounce-back) exhibited in many cases. Indeed, some of the predictive economic models [4] considered two scenarios of SARS lasting one quarter or two quarters, which may explain the over-estimation of effect in some cases. In reality, for many coun-

tries the time from first to last probable case was barely one month. These assumptions were reasonable at the time of the outbreak but the true impact did not reach the heights of some model predictions.

It is also necessary to remember that the death toll from SARS was less than 1000 worldwide, and since most countries had fewer than ten (and in many instances no) cases of SARS, for many SARS did not become more than a potential threat which did not come to fruition.

Whilst each pandemic is different, and one outbreak cannot be used to precisely determine the cost of another, our results are illustrative of the type of effects that might be expected. For instance, the relative impact between different sectors and countries. Clearly those sectors which rely upon the movement and interaction of people are likely to be most severely affected, and considerably more affected than the health sector. Also, the countries that are most likely to experience the most severe impact are those experiencing the outbreak most severely, with a reasonably robust positive correlation between severity of outbreak and severity of impact.

This leads to another important indication from this work when considering options to mitigate the economic effects of a future pandemic of this sort. For instance, the very obvious economic repercussions from the outbreak provide a frame of reference for the value of investment in policies and interventions designed to address the emergence and transmission of an outbreak. This could be then used to indicate the value to be placed on transparency by governments and early notification of an outbreak which may be used as a case for increased investment in surveillance or cross-national compensatory transfers of funds to support those countries with an outbreak in the notification of it. In addition, this work demonstrates that the economic impact is determined largely by the desire of people to reduce their public interaction (travel, leisure, tourism), which indicates the importance of portraying a correct understanding of the risk posed by the outbreak to the population. In this respect, it is interesting to reflect upon the possible role of the media in exacerbating or dampening the impact of SARS upon economic activity. It has been concluded elsewhere that “the general consensus is that the media coverage of SARS was excessive, sometimes inaccurate, and

sensationalist” [3, p. 3117]. However, the role of the media in the communication of risk, and how this is interpreted and acted upon, remains an area for debate, and certainly attempting to quantify the impact of media portrayal of the outbreak in economic terms is beyond this paper and has not been undertaken elsewhere. Of more general importance for the impact of future outbreaks, and the policy response to them, might be the impact that exaggerated media reporting of a number of such outbreaks may generate either a more general climate of ‘fear’, and thus exacerbating the response to each individual outbreak, or desensitizing the public to the effects of such outbreaks, if the reality consistently falls short of the rhetoric [3]. Clearly the role of media, and more general communication, concerning outbreaks requires further research.

This leads naturally on to the consideration of wider outbreak control policies. For example, border closures are likely to be expensive but ineffective [10–12], school closures during the pandemic would introduce costly absenteeism by working mothers [13] and therefore closure at the peak of the pandemic only would be much less costly than whole pandemic closure. Border screening is also an unnecessary cost since it only detects those who are at certain stage of disease progression from entering a country [12]. Whilst these measures may be used to inspire public confidence and political assurances that appropriate action is being taken, alternatives such as vaccines, antivirals or advanced funds for use in such situations, as outlined elsewhere [14], might provide a more cost-effective return.

5. Conclusions

SARS constitutes an example of a disease outbreak that highlights potential shortcomings in health cost estimation and in model application. This paper has demonstrated that the majority of costs related to a pandemic outbreak are likely to occur in the non-health sectors and therefore cannot be estimated using traditional micro-economic analysis [15]. In addition, SARS has shown that some macro-economic modelling techniques do not accurately predict the impact of infectious disease outbreaks of this kind. It is important that, in the event of an influenza pandemic

for instance, both *health* policy and *public* policy are informed by accurate information and therefore an accurate macro-economic model of the economic impact of infectious disease across sectors and countries is required.

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